Synthesis of EXPERT RESPONSES

Clarkson Airshed Expert Consultation

MAY 28 2009

Preface

This report was prepared by Ogilvie, Ogilvie & Company and the opinions expressed in it are those of Robb Ogilvie (Managing Partner) and Dr. Isobel Heathcote (Technical Facilitator and Editor).

In September 2008, the Ministry retained Ogilvie, Ogilvie & Company (OOC) to review the functioning of the CASAC and recommend changes.

One of our findings was that the lack of persuasive science was resulting in fruitless debates that did not lead to any conclusion or result in any actions that lead to a path forward. There was therefore a need to obtain sound science advice in support of future discussions about monitoring and air pollution control in the Clarkson Airshed.

We subsequently organized and managed an “expert consultation” process in search of answers to the following:

- Are people in the Clarkson Airshed experiencing adverse health effects because of the air quality conditions?
- Who is responsible for the observed occasional high $PM_{2.5}$ concentrations (and those of other pollutants)?
- Was the computer simulation model appropriate for the situation? was it appropriately applied?
- Are the principal air pollution sources really vehicular?

This document is our synthesis of the expert consultation. The companion document contains the verbatim responses of the experts to the questions we asked them.

Expert Consultation using the Delphi Method

This expert consultation was directed by an Inter-Agency Health and Environment Working Group composed of senior members of Ministry of the Environment, Peel Region Health Dept. and Halton Region Health Dept. Dr. Isobel Heathcoate from OOC organized and managed the following process:

- The Inter-agency Working Group invited five distinguished researchers to provide expert advice, and developed a tentative list of questions that these experts deliberated on.
- The questions were sent separately and anonymously to the experts. The experts were asked to provide a brief written response on each question, including any rewording of, or additions to the questions asked. All of the questions were sent to all of the experts, but we asked that they only provide answers within their area of expertise.
- The responses from each group were summarized and the summary given to each participant for review. Each expert was then given the opportunity to modify or expand on his/her responses, through a second round of questions.

List of Experts

Human Health Experts

Michael Jerrett: Associate Professor, UC Berkeley, Environmental Health Sciences (note he has a PhD from U of Toronto, 1996 and BS from Trent University); research interests include Spatial analysis of disease-exposure associations using Geographic Information Science; geographic exposure modeling, land use characterization.

Michael Brauer, Professor, School of Environmental Health and Department of Medicine/Atmospheric Science Programme, College for Interdisciplinary Studies, University of British Columbia. His research interests include environmental and occupational exposure assessment, air pollution health effects, and development of sampling and analysis methods for air pollutants.

Monitoring/Modelling Experts

Gary Foley, Director, US EPA’s National Council for Regulatory Environmental Modeling (CREM), Office of Research and Development, US EPA (Triangle Park, NC). CREM was established in 2000 to promote consistency and consensus among environmental model developers and users. The CREM council consists of senior managers from across the Agency, while CREM workgroup members consist of modelers and scientists from the program offices and regions.

Stuart A. McKeen, Atmospheric VOC Research Group, Cooperative Institute for Research in Environmental Sciences (CIRES)/University of Colorado and NOAA/AL, Boulder, Colorado; research interests in the modeling and monitoring of $PM_{2.5}$.

Ann McMillan is currently on a special assignment with Fisheries and Oceans Canada, but previously with Environment Canada, where she spent almost 20 years supervising air quality modeling, air quality assessments, and science-to-policy work. Former Chair of the Science Subcommittee under the Canada/US Air Quality Agreement for a decade and initiated the science assessment work on air quality modeling of particulate matter as the basis of a transboundary assessment. Currently Canadian Co-Chair of the International Air Quality Advisory Board of the International Joint Commission.

First Round Questions

FEBRUARY 2009

Note: In some cases, the experts referred to "studies" or "patterns" without providing detailed explanations. We have taken these comments at face value and have not attempted to obtain the original materials on which they are based.

1 How does air quality in the "Clarkson" Airshed compare to:

- Other urban areas with a significant industrial sector?
- Other urban areas in or nearby large volume traffic corridors (including a busy international airport)?
- Other nearby municipalities (e.g., Mississauga, Brampton and Oakville) or similar suburban "bedroom" communities located close to major transportation corridors and airports?

Reasons for asking the question: For many years, Clarkson residents have expressed concern that air quality in their region is impaired and may be significantly worse than the average in Ontario. These concerns were in fact one of the driving forces behind the Clarkson Airshed Study Parts II and III. We therefore felt that it was important to seek the advice of experts from other parts of the continent, with experience in urban systems throughout the world. We wanted to know how air quality in the Clarkson airshed compares with similar urban areas elsewhere.

Responses of the experts:

- All experts felt that the air quality in the Clarkson Airshed was typical of urban areas with significant industry; several noted that observed air quality in the Clarkson Airshed displays patterns (e.g., decay patterns away from source, seasonal patterns, diurnal patterns during rush hour, etc.) that are typical of urban areas with industrial development, for instance higher traffic-related pollutants such as NOx during rush hour and close to major highways.
- One expert said the observed values are typical of levels at 119 urban and suburban monitors in the US Northeast. Two experts noted that concentrations of some parameters indeed seemed low for an urbanized area ("Clarkson is pretty clean").
- Several experts observed that traffic hotspots (areas of impaired air quality close to traffic corridors) are common in urbanized areas and are not surprising here.

From the experts' responses to this question, we draw the conclusion that air quality (and presumably risk to human health) in the Clarkson Airshed is typical of urban areas in Canada and the United States, and better than most urbanized areas of Europe and Asia.

2 Is the scientific approach of the Clarkson Airshed study generally appropriate? Is the modelling and monitoring sufficiently rigorous to characterize and apportion emission sources by contributing sector or land use?

Reasons for asking the question: Computer simulation models can be helpful in understanding air quality phenomena in an area like Clarkson, and monitoring is necessary, both for regulatory purposes and as a basis for understanding current conditions. There are many different approaches to monitoring and modelling, however, and some observers have challenged the validity of the CAS Part III modelling as a basis for source apportionment. We therefore felt it was important to seek the experts' opinions on the Clarkson Airshed Study work to date.

Responses of the experts:

- The experts were generally in agreement that the Clarkson monitoring approach is appropriate, and measurement techniques appear sound and consistent with accepted approaches elsewhere. While some experts recommended additional monitoring (either more stations or more substances, or both), they also recognized that monitoring is expensive, especially for very intensive ("saturation") sampling. The costs of additional monitoring should therefore be weighed against the information to be gained from such monitoring. Some of the experts' suggestions fell more into the realm of research rather than routine monitoring, and could be set aside for a future collaborative research effort involving researchers from local universities.
- The experts noted that several kinds of monitoring may be appropriate in Clarkson. These include ambient air quality monitoring and source (emissions) monitoring, to determine current conditions and regulatory compliance, and human health impact assessment.
- The consensus among several experts was that the modelling approach appears to be reasonable and appropriate for simulation of air quality on a relatively large scale (neighbourhood and regional scale). Several experts noted that the modelling, like any other similar exercise, has limitations, especially in predicting pollutant concentrations at a very local scale (individual residence scale), and for source apportionment.
- The experts suggested various refinements to the Clarkson Airshed modelling, but acknowledged that significant effort (and presumably cost) would be involved in such work. Examples of suggested improvements include modifying the model to add the influence of automobile and truck trips associated with the presence of industrial facilities; applying the air quality model to the population (not just the monitoring sites) to provide more information on population-weighted source impacts; and attempting to capture the dynamic, "episodic" nature of air mass movement caused by meteorological conditions. That is, trying to simulate air mass movement hour by hour, rather than as average conditions. There was no particular consensus about the best way to improve the model, or indeed about whether additional modelling was required at all. The consensus seemed to be that the modelling had provided useful insight into average conditions, but more detailed monitoring studies would be needed for source apportionment and health risk assessment.

3 Is the current regional-scale ambient air monitoring system (Air Quality Index – AQI) sufficient to represent local air quality conditions or to identify local air quality impacts? If there are data gaps, what are the gaps and how can they be filled?

Reasons for asking the question: Air quality varies continuously in response to wind and weather conditions, changing emissions from industrial sources and traffic, and various other factors. Air quality monitoring is therefore a challenging task: how many stations, located where, are necessary to capture an accurate picture of air quality at any given time?

The Clarkson neighbourhood is located in a heavily urbanized region, and its air quality is affected by numerous local sources and meteorological conditions. Air pollutants from the US Midwest are also transported into the Clarkson area by prevailing winds from the southwest. Ideally, we would need an air quality monitor on every street corner and roof top, but practically speaking this is just not feasible, not only because of financial constraints but also because of aesthetic and safety concerns.

The Air Quality Index (AQI) is an indicator of outdoor air quality in Ontario. The lower the AQI, the better the air quality. Currently, the Ontario Ministry of the Environment operates 40 Air Quality Index (AQI) monitoring sites across the province. Three of those sites, in Burlington, Mississauga, and Oakville, are close enough to Clarkson to provide insight into air quality in the Clarkson neighbourhood. Six key air pollutants are monitored continuously by the Ministry as part of the AQI: sulphur dioxide, ozone, nitrogen dioxide, total reduced sulphur compounds, carbon monoxide, and fine particulate matter ($PM_{2.5}$). These pollutants were chosen because they have an adverse effect on humans and the environment at high levels. AQI data are used to determine the state of air quality in Ontario and to develop pollution control programs. AQI readings are reported to the public and news media at set intervals each day. The data is also used to issue smog watches and advisories.

Part II of the CAS involved the design and implementation of a more intensive ambient air quality monitoring program between June 2003 and March 2005. The program employed six monitoring stations, in addition to the existing AQI stations, and one meteorological (weather) station. The purpose of this monitoring was to gain insight into the sources of observed air quality problems, to determine the background concentrations of target pollutants, and to estimate the impact of each sector on air quality in the study area. The data were collected in an area bounded by

the Queen Elizabeth Way to the north, Winston Churchill Blvd to the west, Southdown Road to the east and Lake Ontario to the south. The locations of the six CAS monitoring stations were as follows:

1) STATION # 44075, 9th Line and North of QEW, Oakville, Stn QEW West

2) STATION #44080, MTO Rd., South Sheridan Way and QEW, Oakville, Stn QEW East

3) STATION #44086, Deer Run, West of Winston Churchill Blvd., Oakville, Stn 44086 Residential

4) STATION #44083, South of Ford Dr., West of Royal Windsor Dr., Oakville Stn Ford Dr.

5) STATION #46128, Royal Windsor Dr. and Winston Churchill Blvd, Mississauga Stn Industrial Centre

6) STATION #46117, Meadow Wood Park and East of Southdown, Mississauga (existing MOE STN) Industrial East

Question 3 seeks the experts' advice as to whether the current sampling network is sufficient to measure local air quality conditions accurately, and provide a basis for assessing human health impacts, or whether they believe additional data should be collected.

Responses of the experts:

- Several experts observed that the existing air quality monitoring network is probably adequate to assess daily and seasonal (but probably not hour-by-hour) variations in air pollutants across the Clarkson neighbourhood as a whole.
- Specialized studies would be necessary to study how air quality changes over short distances, say tens or hundreds of meters (for example, from house to house). These studies would require a very large number of monitors covering a small area ("saturation monitoring") and would therefore be costly to implement.
- There are many air quality monitoring stations across the eastern US and southeastern Canada. This large network produces reliable data on regional air quality, and is helpful in understanding larger-scale movement of air pollutants, for example through long-range transport from the US Midwest.
- The AQI methodology referred to in the Clarkson Airshed study has been in place for many years in Ontario. Health Canada has recently proposed a new (federal) Air Quality Health Index that uses the data in a somewhat different way to provide a forecast that is more closely linked to health effects.

4 What do air levels of common pollutants in the south Mississauga/south Oakville area mean for population health risk?

Reasons for asking the question: It has been said that there is no such thing as a "risk-free" environment, but it is important to know if Clarkson air quality is likely to pose health risks for residents, greater than or different from those in the rest of Ontario. Elevated health risks, relative to other urbanized areas of the province, would almost certainly require intervention by the Medical Officer of Health, and would justify additional intensive monitoring to pinpoint pollutant sources. Health risks from air pollution can range from nausea and headaches to eye irritation, asthma, bronchitis, and cardiovascular disease. The human health impacts of the AQI pollutants are as follows:

Sulphur Dioxide

Health effects caused by exposure to high levels of SO_2 include breathing problems, respiratory illness, changes in the lung's defences and respiratory and cardiovascular disease. It can irritate your nose, throat and lungs. It may cause coughing, wheezing, phlegm and asthma attacks. The effects are worse when you are exercising. People with asthma, chronic lung or heart disease and children are the most sensitive.

Ozone

Studies show a wide variety of effects caused from exposure to ozone. In the short term, these include irritation to your eyes, nose and throat, coughing and headaches. Exposure to high levels can result in chest tightness, coughing and wheezing. It also contributes to asthma. People with respiratory and heart problems, asthma and lung disease are at a higher risk, as are healthy adults exercising for long periods of time outdoors. Exposure to ozone has been linked to increased hospital admissions and premature death.

Nitrogen Dioxide

The main health effect of NO_2 is on the respiratory system. Inhalation of nitrogen dioxide by children increases their risk of respiratory infection and may lead to poor lung function in later life. There is also an association between nitrogen dioxide concentrations in the air and increases in daily mortality and hospital admissions for respiratory disease. Nitrogen dioxide can decrease the lungs' defences against bacteria, making them more susceptible to infections, and can also aggravate asthma. Sensitivity increases for people with asthma and bronchitis, young children, and adults with heart and respitory disorders.

Total Reduced Sulphur Compounds

TRS compounds are not normally considered a health hazard, although each component has its own characteristics and effects. The most commonly reported health concerns related to TRS substances are nausea and headaches. TSR are, however, a primary cause of odours.

Carbon Monoxide

When you breathe in carbon monoxide, it attaches to the hemoglobin molecules in your bloodstream, which carry oxygen around your body to your tissues. Carbon monoxide reduces the amount of oxygen that your body tissues receive, which is particularly bad for your brain, heart and general health. Carbon monoxide can make you feel dizzy, weak, nauseous, confused and disoriented, and can also reduce your performance while doing exercise. The higher the level of carbon monoxide in your blood stream, the worse the effects. So at very high levels, coma, collapse, loss of consciousness and death can occur. The groups that are most sensitive to carbon monoxide are middle-aged and elderly people with heart disease and unborn babies.

Fine Particulate Matter ($PM_{2.5}$)

Some of the most common health effects include irritation of your eyes, throat and lungs. For people with existing respiratory conditions, such as asthma, bronchitis, cardiovascular or lung disease, breathing in particles can make the conditions worse. Children and elderly people are also more sensitive to the effects of PM.

Particles can also reduce your capacity to resist infection. Studies show that particles can increase the number of hospital admissions and emergency department visits, school absences, lost work days and restricted activity days.

This question asked the experts to comment on the significance of observed pollutant levels.

Responses of the experts:

- The experts' comments suggested that health risks in the Clarkson Airshed are no higher, and are probably somewhat lower (due to frequency and occurrence of the relatively clean westerly and north-westerly wind sector) than those in any other North American urban area.
- One expert stated that they would not be concerned about health effects unless the levels were often and substantially above CCME Air Quality Objectives and Guidelines levels (proposed Canada-Wide Standards, or CWS) for PM_{10} and $PM_{2.5}$, because those levels were chosen as levels below which no health effects were observed.
- Note: Data from the CAS ambient air monitoring program indicated that annual average 98th percentile 24 hour concentrations of $PM_{2.5}$ measured at four of the six CAS stations exceeded the proposed CWS concentration of 30 $\mu g/m^3$ both for 2004 and for the whole study period (2003-2005). The 98th percentile value for the complete study period ranged from 25.2 $\mu g/m^3$ at Stn Industrial Centre to 40.7 $\mu g/m^3$ at Stn QEW East. The average 98th percentile concentration for all monitoring stations was 32.8 $\mu g/m^3$. These elevated levels were found to be particularly evident during smog events and were due largely to vehicular emissions, long range transport and industrial source emissions. The elevated concentrations occurred when the wind direction was predominantly from the south and south-southwest. Jurisdictions are expected to meet the CWS for $PM_{2.5}$ by 2010.
- Based on these results and the experts' responses, we conclude that while air quality in the Clarkson neighbourhood occasionally exceeds benchmark levels, generally speaking human health risks are typical of large urban areas and probably lower than many.

First Round Questions

5 What, from a public health perspective, are the air contaminants of greatest concern? Are there particular contaminants on which the Ministry of the Environment and other stakeholders should focus?

Reasons for asking the question: The Ministry of the Environment's current monitoring program is tied into a province-wide monitoring strategy, the AQI system described previously, which focuses on six target pollutants. This question is geared to understanding whether any other contaminants should be monitored, or whether certain parameters in the current monitoring should be emphasized.

Responses of the experts:

- The experts generally agreed that the key pollutants of concern are those that are most common in other urban environments, namely $PM_{2.5}$ and ozone, both of which are currently part of the AQI monitoring system. Other pollutants, such as volatile organic chemicals (VOCs) and NOx, have human health impacts but also contribute to the formation of particulate matter and ozone.
- Ozone is a pollutant that tends to be distributed over a large region, and is already well-characterized with the existing monitoring.
- One expert noted that the industrial impact (estimated at 25% of $PM_{2.5}$ for Clarkson) seems quite high compared to other urban areas.
- Another expert said that specialized studies, for example of diesel particulate composition, may help to shed light on the role of traffic-related pollutants.
- There is growing interest in the role of ultra-fine particulates (UFPs) – very fine particles, smaller than $PM_{2.5}$, typically less than 100 nanometres in diameter – but little is currently known about this group of pollutants. Similarly, little is known about nanomaterials (materials of various kinds that are smaller than one–tenth of a micrometre in at least one dimension) or the cumulative effects of various mixtures of air pollutants. These may be potential areas for future research in the Clarkson area.
- We therefore conclude that the current AQI monitoring system is focusing on an appropriate group of air pollutants. There are many interesting avenues for future research, including the composition of $PM_{2.5}$ and determination of the degree to which ultrafine particles and nanomaterials contribute to air pollution in the GTA. However, measurement techniques for these kinds of materials are still under development, so they are not yet candidates for routine monitoring.

6 If additional monitoring is warranted for the Clarkson Airshed, what should the objective(s) and goal(s) of that monitoring be (i.e., improved understanding of local air quality processes? Emissions contributions by sector? Linkage of air quality to public health? Improved understanding of multiple source cumulative effects?)

Reasons for asking the question: As was noted previously, designing a monitoring system is a challenging task, and involves trade-offs between the significant costs of adding monitoring stations and pollutant analyses, and the additional information that would be gained from such monitoring. It is important to begin with a clear question, for example, "What is the average concentration of $PM_{2.5}$ in Clarkson?" or "What is the maximum ambient concentration of ozone that is likely to occur in Clarkson?" Available resources for monitoring are limited, so a clear question lets you plan carefully for the location and timing of monitoring, and the pollutants you will measure. It also lets you identify gaps in your current monitoring, and set out a strategy for analyzing the data you have collected, so you can answer the questions that drive the monitoring. With Question 6, we invited the experts to suggest priorities for future monitoring.

Responses of the experts:

- Several experts recommended additional work to determine the relative contribution of different sources (e.g., industrial sources, traffic, long-range transport from the US) to observe air quality in Clarkson.
- For example, it would be possible to identify the sources of VOCs from individual monitoring stations by comparing known VOC "signatures" (characteristic proportions of organic compounds) from individual industrial sources, against the VOC combinations measured in the monitoring.
- Electron microscopes can be used to examine fine particulate matter,
- The experts are generally agreed that the goals of a monitoring program are best determined by the stakeholders (government, public, etc.), and that the design of the program will depend on its goal (daily data best for health; long-term trends better for regulatory compliance. Some specific comments included:
  - If the goal of the monitoring program is to understand the link between air quality and health, there is a need to site monitors to assess overall population exposure. But those pollutants have been studied elsewhere and those results could be used here to evaluate health effects unless there is something unique about the airshed. The implication of the experts' comments is that this kind of monitoring is probably unnecessary in Clarkson.
  - If the goal is to understand the cumulative impact of multiple sources, it will be necessary to obtain data over a longer time frame and preferably also the chemical composition of PM. This will probably require a research initiative in collaboration with local university and government researchers.
- Several experts commented that there has been considerable work elsewhere on the link between air quality and human health, and much of that work could be transferred to the current situation The Inter-agency Health and Environment Working Group is familiar with much of this work, and regional health units currently use it as the basis for much of their air quality-related health advice.
- Primary health studies would be necessary for specialized investigations (e.g., asthma impacts on children), but would have to be undertaken by provincial or possibly federal health agencies.
- Various enhanced monitoring approaches are possible, for example "saturation" monitoring employing large numbers of monitors over a small area for a short time period (as discussed previously), or airborne sampling using airplanes or helicopters. However, these methods are costly and it would therefore be important to ensure that the additional information provided by such monitoring justifies the cost.
- Based on these responses, we conclude that the current AQI monitoring system is adequate for tracking regional ambient air quality patterns and trends, but that additional research would be helpful in shedding light on a variety of questions, such as the sources of particulate matter. We recommend that the IAWG consider opening a dialogue with air quality researchers at local universities and in provincial and federal agencies, with a view to developing a long-term collaborative research plan. Funding for that research should be sought from federal granting councils and private foundations.

7 Please add any other comments or information that you feel may be useful to us in this review.

Comment: We invited the experts to add any other thoughts on the CAS methodology, or suggestions for additional work.

Responses of the experts:

- Most of the experts' additional suggestions related to health assessment techniques and considerations, for example:
  - the relative importance of local sources (e.g., cigarette smoke) versus distant sources (e.g., distant power plant emissions)
  - assessment of the relative proportions of pollutants that are actually breathed by people in the region (intake fraction), rather than estimating risks based only on emissions inventories and ambient air quality.
- One expert observed that (based on data from another study), there is a clear diurnal (daily) cycle in air quality in the Golden Horseshoe region ("like a tide raising ships in a harbour"), for example morning and afternoon $PM_{2.5}$ peaks that coincide with rush hour traffic periods. He suggests that this means that air quality in Clarkson is probably strongly influenced by regional air quality (not just local sources), especially during smog events.

Second Round Questions

APRIL 2009

1 Please give examples from your experience of the typical relative contribution of vehicular (i.e., traffic) vs. industrial sources of $PM_{2.5}$, NOx, and carbon monoxide.

Reasons for asking the question: The Round 1 responses suggested that additional source apportionment (define/explain) studies may be desirable, but that these would likely involve complex, high-cost sampling, for example of the chemical composition of $PM_{2.5}$. It occurred to us that the experts might be able to suggest typical sectoral (define/explain) contributions of air pollutants. This question therefore asks the experts to comment on typical $PM_{2.5}$, NOx, and CO contributions from vehicular vs. industrial sources.

Responses of the experts:

- Generally speaking, the experts agreed that the relative contribution of different sources will depend on the region and possibly the time of year. Typically, CO is more dominated by traffic sources than are either $PM_{2.5}$ or NOx. Vehicular traffic typically contributes half to two-thirds of observed CO.
- Vehicles can also be a significant source of NOx.
- By contrast, vehicles contribute a much smaller proportion of $PM_{2.5}$ mass, often less than 10% and typically less than 25% of the total. Diesel vehicles are particularly important sources of vehicular $PM_{2.5}$.

2 Are transboundary sources likely to be a significant influence in periods of poor air quality in the Clarkson Airshed?

Reasons for asking the question: Some of the Round 1 responses suggested that Clarkson receives a significant proportion of its air pollutant loadings from sources outside the airshed, and probably outside the country.This question seeks to confirm and clarify that point with the experts.

Responses of the experts:

- The experts generally agreed that both local and transboundary sources contribute to observed air quality in Clarkson. Some of the pollutants of concern ($PM_{2.5}$ and ozone) are formed through chemical and physical transformation in the atmosphere (for example, ozone is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOCs) in the presence of sunlight). It is therefore likely that some of the pollutants measured in Clarkson in fact were formed from emissions from sources well outside the Clarkson area. When prevailing winds are from the southwest (in particular) or the southeast, they bring air pollutants that are emitted in the United States, for instance from coal-fired generating stations in the US Midwest. Summer ozone and photochemical smog episodes in particular are likely to be impacted by transboundary pollution from those sources.
- The relative magnitude of the transboundary, regional and local source impacts is difficult to determine without chemical transport modeling, receptor modeling (e.g., source apportionment with trajectory analysis) or other similar approaches.
- We conclude from these comments that transboundary sources are likely to be a significant influence on air quality in the Clarkson area, especially during smog events. It is likely that the proportion of those sources relative to other sources varies with wind direction and other meteorological conditions.

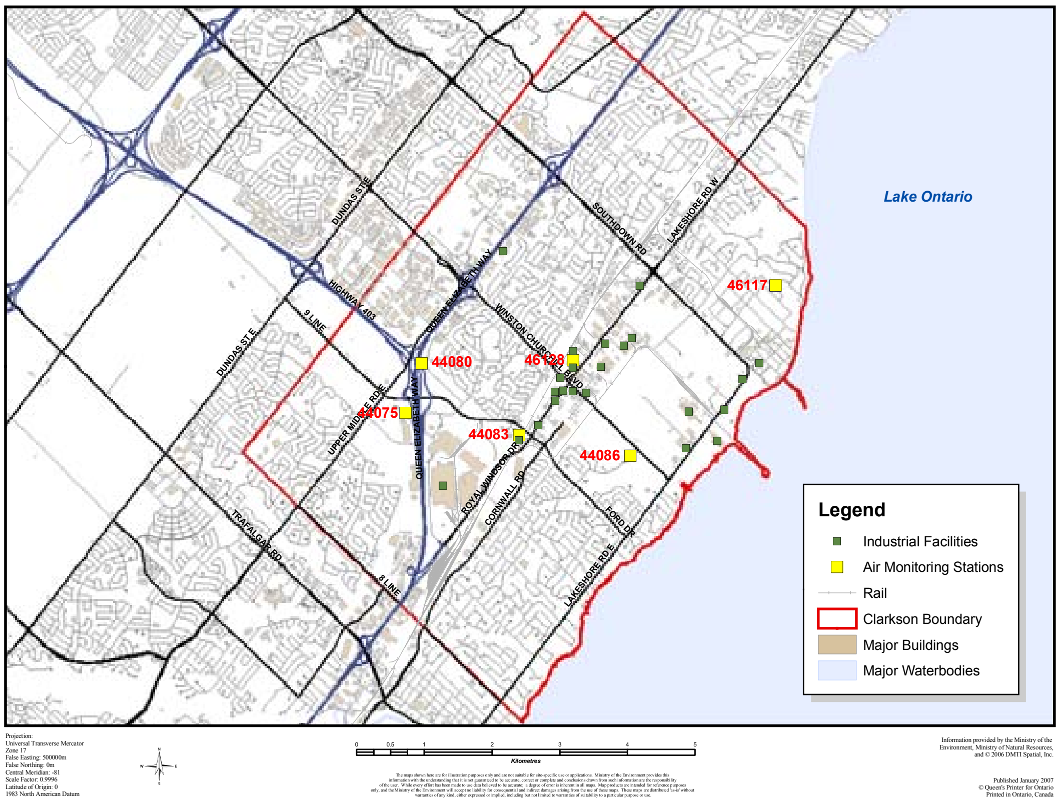
3 What could Ontario and/or Canada do to apply the lessons from the Clarkson Airshed at a broader scale, along the lines of "areas of attainment" as currently used in the US? What are US EPA and states doing to make this approach successful? Are there any other approaches (for example, from Europe) that we should be examining?

Reasons for asking the question: The United States uses a fundamentally different approach to air pollution control and regulation than is used in Ontario. The US system focuses on "areas of attainment" for target air pollutants. In the case of ozone, for example, when an area is designated as "nonattainment", the state and local governments have three years to develop implementation plans outlining how areas will attain and maintain the standards by reducing air pollutant emissions contributing to ground-level ozone concentrations. This system makes responsibility for enforcement clear, and is backed with comprehensive air quality monitoring. In Ontario, air emissions are regulated on a "point of impingement" basis, where a point of impingement is defined as the nearest point where air contamination emitted by a source will impinge on a building or beyond the property line. Point of impingement must be estimated from computer simulations, and it can be argued that this system is more difficult to enforce. We were interested in learning from the experts whether there are any lessons that could be transferred from the US experience, or from other jurisdictions elsewhere, to the Ontario setting.

Responses of the experts:

- The fundamental differences in the US and Ontario systems made it difficult for the experts to answer this question in the way we had intended.
- It was clear from the experts' answers that effective enforcement is essential for good air quality management ("…in the U.S. there are substantial financial penalties and regulatory actions following designation as non-attainment. So, the basic issue is lack of enforcement in Canada, combined with the absence of penalties or legislated action if standards are exceeded").
- One expert commented that "the CWS for PM and Ozone are generally recognized to have been set at levels that were believed to be achievable and not necessarily only considering health impacts". The implication of this comment is that there is a need to set air quality standards at a level that is protective of human health, not just reasonably achievable for emitters. The European Union is currently reviewing its air pollution control framework, for instance by tightening emissions standards for new vehicles, and that experience may have important lessons for us in Ontario in terms of regulatory approaches, air pollutants of concern, and measurement techniques for newly-identified substances such as nanomaterials.

Clarkson Airshed Study



Projection:
Universal Transverse Mercator
Zone 17
False Easting: 500000m
False Northing: 0m
Central Meridian: -81
Scale Factor: 0.9996
Latitude of Origin: 0
1983 North American Datum

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Published January 2007
© Queen's Printer for Ontario
Printed in Ontario, Canada

Second Round Questions

- The existing US/Canada Air Quality Agreement, while not a regulatory instrument per se, has explicit provisions that deal with SOx, NOx, ozone, and VOCs. Clarkson falls within the Pollutant Emission Management Area (PEMA) under this agreement. The PEMA is a transboundary area where emission reductions are most critical for reducing transboundary ozone. Canada and the US are considering adding particulate matter to this agreement.

- The US/Canada Great Lakes Water Quality Agreement contains an annex on air quality in the Great Lakes Basin, including provisions for monitoring through the Integrated Atmospheric Deposition Network (IADN) which monitors background sites for toxics including PAHs.

- We cannot draw any clear conclusions from these comments; the fundamental differences between the US and Ontario systems are likely to continue into the future. It would, however, be worthwhile for the IAWG to continue to monitor the European Union's review and restructuring of its air pollution control framework to determine opportunities for strengthening Ontario's system.

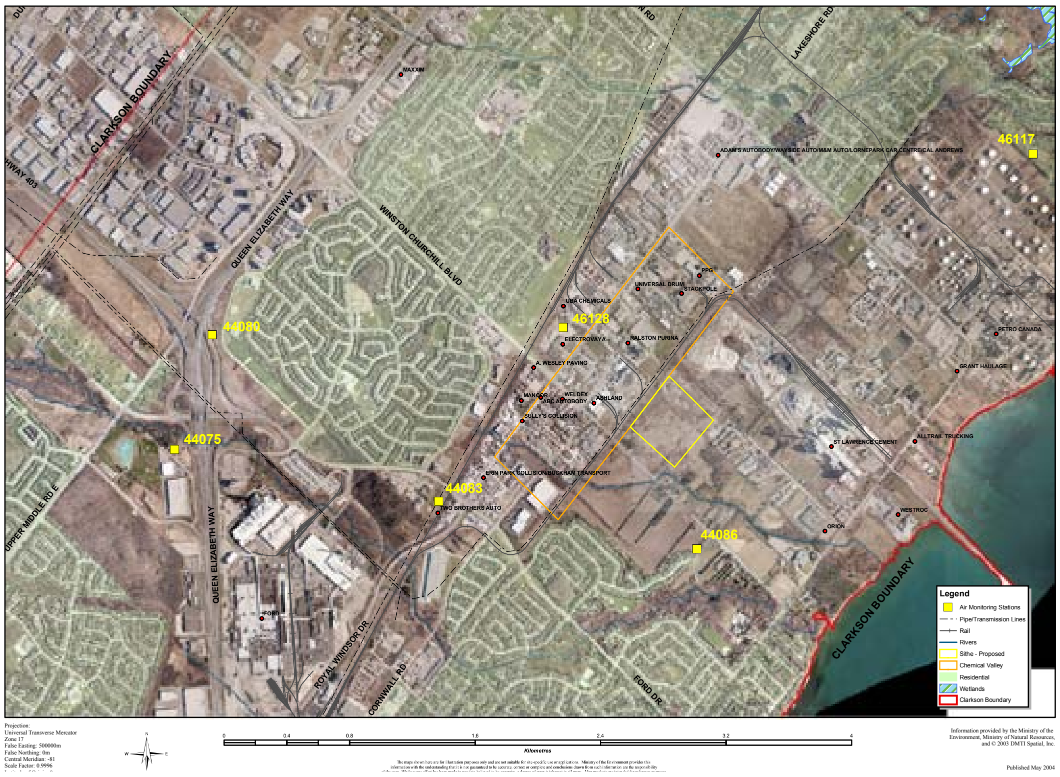
4 Experts have suggested adding analyses for elemental carbon, PAHs, transition metals, ultrafine particles (UFPs) and nanomaterials to the monitoring program for the Clarkson Airshed. Please provide examples of jurisdictions elsewhere (if any) that track and regulate these parameters.

Reasons for asking the question: In the Round 1 responses, the experts suggested a number of approaches to source apportionment and human health impact assessment. However, some or most of those suggestions fall into the realm of research, and there are no regulatory or monitoring programs that are widespread in use. This question seeks to confirm that point with the experts.

Responses of the experts:

- The experts' responses to this question confirmed that while some of these approaches would have value, the installation and maintenance of specialized monitors and "saturation" monitoring networks is expensive and would likely divert funds from existing monitoring programs. It would be preferable to explore some of these questions with research projects that are funded through other mechanisms (research grants, foundations) rather than through Ministry operating funds.
- The US currently monitors not only fine particulate matter ($PM_{2.5}$), but also the portion of $PM_{2.5}$ that is elemental carbon and various metals. Various monitoring networks include the chemical composition of $PM_{2.5}$ but the experts could not identify jurisdictions that currently regulate these parameters in terms of air concentrations. Rather, they are typically studied from a risk assessment perspective.
- The European Union will soon be implementing an ultrafine particle (UFP) vehicle emissions standard, but there is no ambient air quality standard for UFP in Europe or elsewhere at present.
- Similarly, the OECD is beginning to develop a policy framework for nanomaterials, but methods for measuring those materials have not yet been developed.
- We therefore conclude that there are a number of interesting avenues for collaborative research on air quality in the Clarkson area, but we did not find persuasive evidence that current routine monitoring or regulatory frameworks should be modified to add these pollutants of emerging concern.

Clarkson Airshed Study



In summary:

- Air quality in Clarkson is typical of urban areas in Ontario and elsewhere in Canada and the United States, and probably better than in many such areas.
- Ambient air quality in Clarkson, especially during smog events, has the potential to cause a range of human health impacts ranging from eye and throat irritation to respiratory distress and cardiovascular disease. However these impacts are not unique to Clarkson but rather are typical of urban and urbanizing areas.
- Clarkson air quality is affected by a complex mix of local sources (industry, traffic) and long-distance sources (long-range transport of pollutants from the US Midwest in particular), by meteorological conditions (e.g., wind speed and direction), and by traffic timing and density. Some of these sources, such as industrial emissions, are controllable; others, such as long-range transport, are not.
- Traffic probably plays a significant role in levels of certain pollutants, especially carbon monoxide and $PM_{2.5}$. Controlling vehicular sources of these materials will require strategies such as enhanced public transportation systems and more stringent vehicle emissions standards.
- The Ministry's existing air quality monitoring program is adequate for the evaluation of regional patterns of air quality. More detailed or specialized studies to explore human health impacts, determine the relative contribution of sources, or evaluate hour-by-hour changes in air quality, would require significant additional resources, and are probably best undertaken through separately-funded research programs in collaboration with local university researchers.
- We recommend that the IAWG consider opening a dialogue with air quality researchers at local universities and in provincial and federal agencies, with a view to developing a long-term collaborative research plan. Funding for that research should be sought from federal granting councils and private foundations.